5. The connection between the Beta and the Gamma rays, the recent investigation of which has raised new and interesting questions regarding the nature of electro-magnetic radiation itself.

6. The elaborate study of the thorium and actinium series of products, a study which has been chiefly responsible for the extension of the twenty radioactive products known in 1905, to the thirty-two known in 1913.

7. The new evidence for and against the activity of ordinary matter.

8. The bearing of radioactivity upon the age of the earth.

The author's style is always direct and simple and the present book, like its predecessor, can be read by those not trained in severe mathematical analysis. At the same time, the work of compiling has been carefully and thoroughly done, the references to the original articles are complete, and the author has been remarkably successful in dealing fully and fairly with the work of other investigators and in making a thorough and complete presentation of the facts and theories of radioactivity as they stand in the year 1913. This book will undoubtedly be the standard work on radioactivity for the next five or six years at least.

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University of Chicago,
Ryerson Physical Laboratory,
June 2, 1913

SCIENTIFIC JOURNALS AND ARTICLES

The April number (volume 14, No. 2) of the *Transactions of the American Mathematical Society* contains the following papers:

J. L. Coolidge: "A study of the circle cross."

W. W. Denton: "Projective differential geometry of developable surfaces."

K. P. Williams: "The solutions of non-homogeneous linear difference equations and their asymptotic form."

A. B. Coble: "An application of finite geometry to the characteristic theory of the odd and even theta functions."

W. F. Osgood and E. H. Taylor: "Conformal transformations on the boundaries of their regions of definition."

The May number (volume 19, number 8) of the *Bulletin of the American Mathematical Society* contains: Report of the February meeting of the Society, by F. N. Cole; "Three or more rational curves collinearly related," by J. E. Rowe; "Second note on Fermat's last theorem," by R. D. Carmichael; "An extension of a theorem of Painlevé," by E. H. Taylor; "Mathematical physics and integral equations," by W. A. Hurwitz; "Shorter Notices": Schulze's Teaching of Mathematics in Secondary Schools, by J. L. Coolidge; Hime's Anharmonic Coordinates, by J. V. McKelvey; Beutel's Algebraische Kurven, Zweiter Teil, by H. S. White; Scheffer's Lehrbuch der Mathematik für Studierende der Naturwissenschaften und der Technik, by A. R. Crathorne; Sainte-Laguë's Notions de Mathématiques, by R. C. Archibald; Weber and Wellstein's Encyklopädie der Elementar-Mathematik, Band III., by J. B. Shaw; Whittaker's History of the Theories of the Æther and Electricity, Krause's Theorie der elliptischen Funktionen and Mill's Introduction to Thermodynamics, by E. B. Wilson; Annuaire du Bureau des Longitudes pour l'An 1913, by E. W. Brown; "Notes"; "New Publications."

The June number of the *Bulletin* contains: Report of the spring meeting of the Chicago Section, by H. E. Slaught; "Concerning two recent theorems on implicit functions," by L. L. Dines; "Concerning the property Δ of a class of functions," by A. D. Pitcher; "The asymptotic form of the function $\Psi(x)$," by K. P. Williams; "An erroneous application of Bayes' theorem to the set of real numbers," by E. L. Dodd; "Shorter Notices": Weber's Partielle Differential-Gleichungen der mathematischen Physik, Band II., and Föppl's Theorie der Elektrizität, Band I., by J. B. Shaw; "Notes"; "New Publications."

SPECIAL ARTICLES

ACCESSORY CHROMOSOMES IN THE PIG

Several points of interest were brought to light in this study of the spermatogenesis of the pig and the relation of the accessory chromosomes to sex. Unusually good material was available for this investigation and it was found that eighteen chromosomes occur in the

spermatogonia. Two of these, undoubtedly the accessories, are oval in shape and somewhat larger than the others, which are rod-shape.

In the primary spermatocytes ten chromosomes appear in the late prophase of division, eight large bivalents plus the two unpaired accessories. In the metaphase of this division the accessories pass to one pole, undivided, and in advance of the other chromosomes. Thus, this division which is evidently the reduction division gives rise to two different types of secondary spermatocytes. The one type contains eight ordinary chromosomes or autosomes, and the other eight autosomes plus the two accessories.

In the late prophase and early metaphase of division in the secondary spermatocyte four large chromosomes appear in the one type of cell and four plus the two accessories in the other. Thus a second fusion of the autosomes in pairs has evidently taken place. This is not to be looked on as a second reduction division, however, as the autosomes in the late metaphase of division in these cells manifest their bivalent nature again. The secondary spermatocytes containing the four large chromosomes give rise to two spermatids each with four bivalents or eight univalents; and those containing the four large chromosomes and the two accessories give rise to spermatids containing four bivalents or eight univalent chromosomes plus the two accessories which have divided here for the first time since the last spermatogonial division.

The spermatids transform directly into spermatozoa. The conspicuous centrosome emerges from the sphere and divides into two parts which for some time remain connected by a thick strand of material. The anterior centrosome comes in contact with the nuclear wall while the posterior one becomes transformed into a ring through which extends the developing axial filament. In the meantime the sphere migrates around the nucleus to a point opposite the anterior centrosomes where it becomes fixed as the acrosome. Long before the axial filament is fully developed the posterior ring-shaped centrosome is thrown off and lies in the cytoplasm away from the axial filament. During the final development of the spermatozoan a large mass of cytoplasm containing the posterior centrosome is thrown off by the cell. Careful measurements of a large number of the mature spermatozoa show that they are of two distinct types, one being much larger than the other.

The investigation was extended to studies of the germinal and somatic cells of both male and female pig embryos. It was again found in the male that the spermatogonial number of chromosomes is eighteen and that the same number prevails in the somatic cells, two of the chromosomes being somewhat larger. Twenty chromosomes, four somewhat larger and evidently the accessories, were found in the oogonia, and the same number prevails in the somatic cells of the female. It is evident that the eggs containing the reduced number of chromosomes, which is ten, when fertilized by the one type of spermatozoan containing ten chromosomes give rise to individuals containing twenty chromosomes in their cells, or females; while those fertilized by the other type containing only eight chromosomes give rise to individuals with eighteen chromosomes in their cells, which was found to be the number in the male.

Many investigators have found a similar dimorphic condition in the number of chromosomes in the two sexes of some of the invertebrates; and although the same condition was predicted to exist in the vertebrates possessing the X-element, it has, heretofore, never been actually shown.

N. E. Jordan in a recent abstract[1] says that the heterochromosomes are unquestionably lacking in the pig and several other mammals. Since the appearance of this article I have carefully reinvestigated my material and am thoroughly convinced that my conclusion is correct. A detailed account of this investigation will be published later.

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January 30, 1913

[1] SCIENCE, N. S., Vol. XXXVII., No. 946, pp. 270–271.